



# The MESSENGER Mission to Mercury



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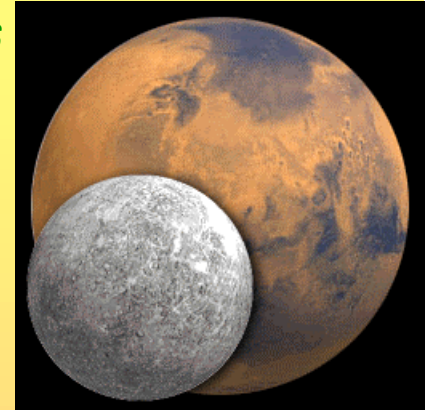
**2003 MU-SPIN Cyber  
Conference: Space  
Science Agenda**

**29 October 2003**

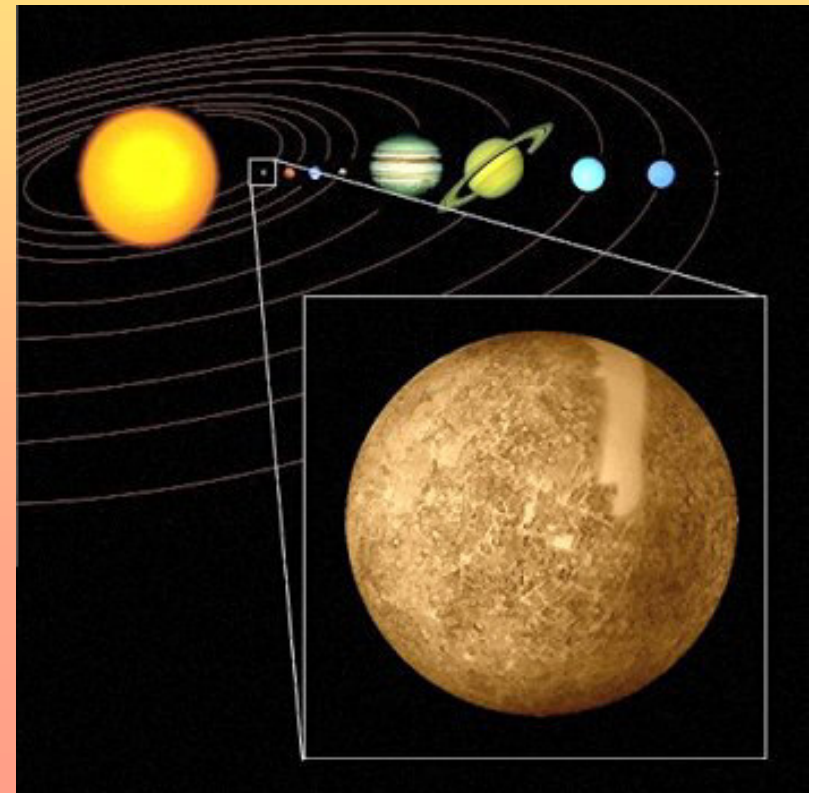
# Mercury is a fascinating, yet *extreme* planet



*Mercury's size compared with Mars*



- **Closest** to the Sun, Mercury has ice caps
- Mercury is the **smallest** planet, except for Pluto
- Mercury is like a “Baked Alaska”: broiling hot on one side, bitterly cold at night
- Mercury is (almost) the heaviest planet for its size: it is mostly iron
- Mercury has a magnetic field despite spinning slowly and being geologically “dead”

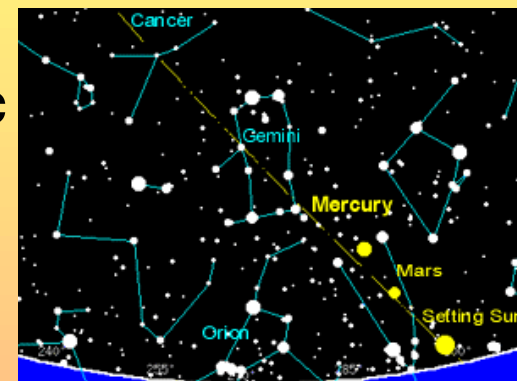


# Yet Mercury is Difficult to See or Observe

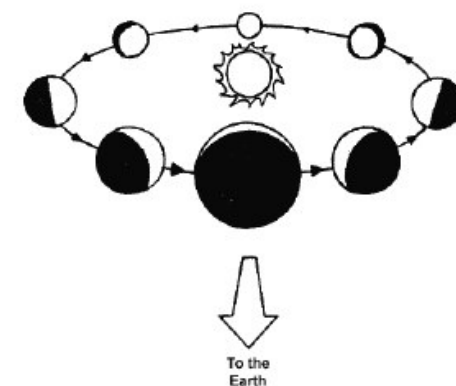


- It is always close to the Sun, so it is a “race” between Mercury being too close to the horizon and the sky being too bright
- Challenges for telescopic observation
  - Bad seeing near horizon
- Mercury is visible several times a year
  - just before sunrise
  - just after sunset
  - Difficult to calibrate H<sub>2</sub>O 0.95μm band
  - Bad seeing, poor calibration during daytime

*Finder Chart*



*Phases Like the Moon*

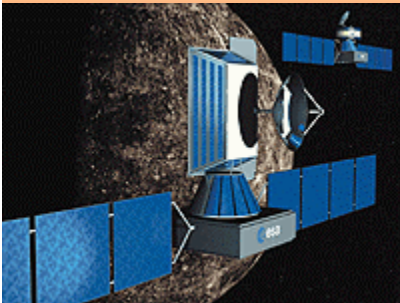


# Mercury's Strange "Day"



*Bepi Colombo*

*A prospective  
ESA mission to  
Mercury is named  
after him*

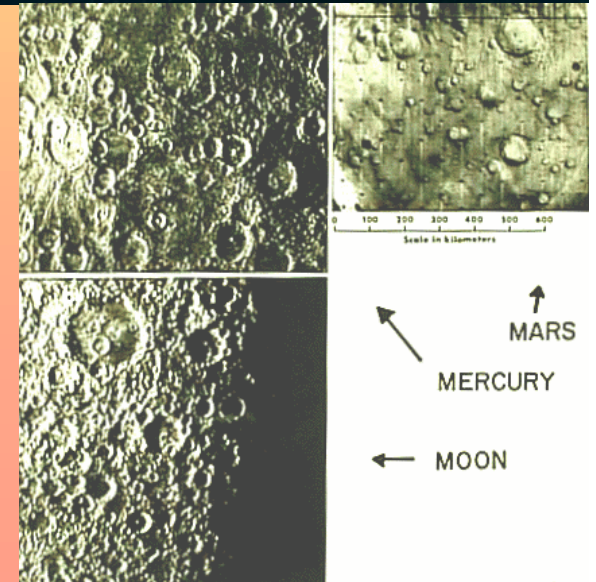


- Mercury does *not* keep one face to the Sun like the Moon does to the Earth... but it is trapped by huge solar tides into a 2/3rds lock: **its DAY is 2/3rds of its 88-(Earth)day YEAR, or 59 days.**
- But that's its "day" (time it spins) with respect to the stars. Its "solar day" (time between two sunrises) takes two Mercurian *years* (176 Earth-days).
- All this was explained more than 30 years ago by the Italian physicist, Bepi Colombo

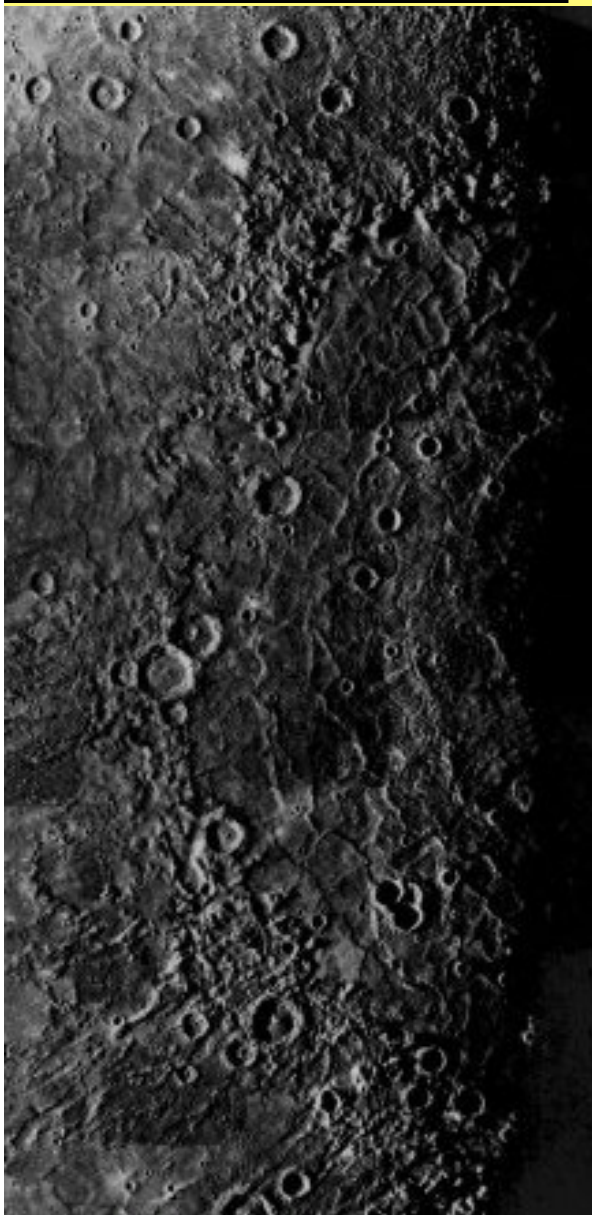


# First (and last, so far) Mission to Mercury: Mariner 10

- This early spacecraft made 3 flybys of the same side of Mercury in 1974 and 1975
- It took what are still the best pictures we have of its surface and made many discoveries:
  - Mercury has a magnetic field
  - Mercury's crust has buckled
  - Mercury's geology is much like the Moon's



# Mariner 10 Views of Mercury





# Mariner 10 Found Many Things...

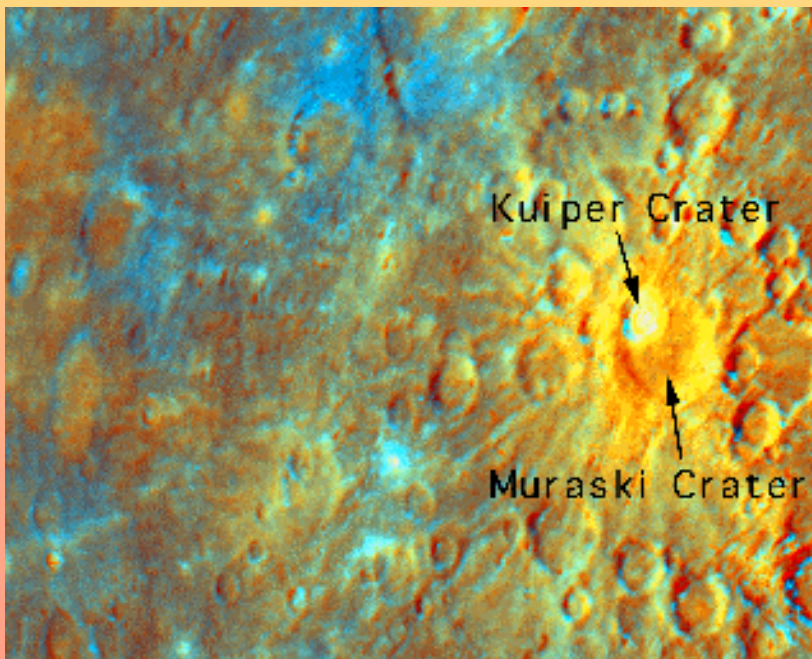
**But Very Little about...**

**Mercury's Surface Composition, its Deep Interior, the Time Variability of its Thin Atmosphere and Magnetosphere...**

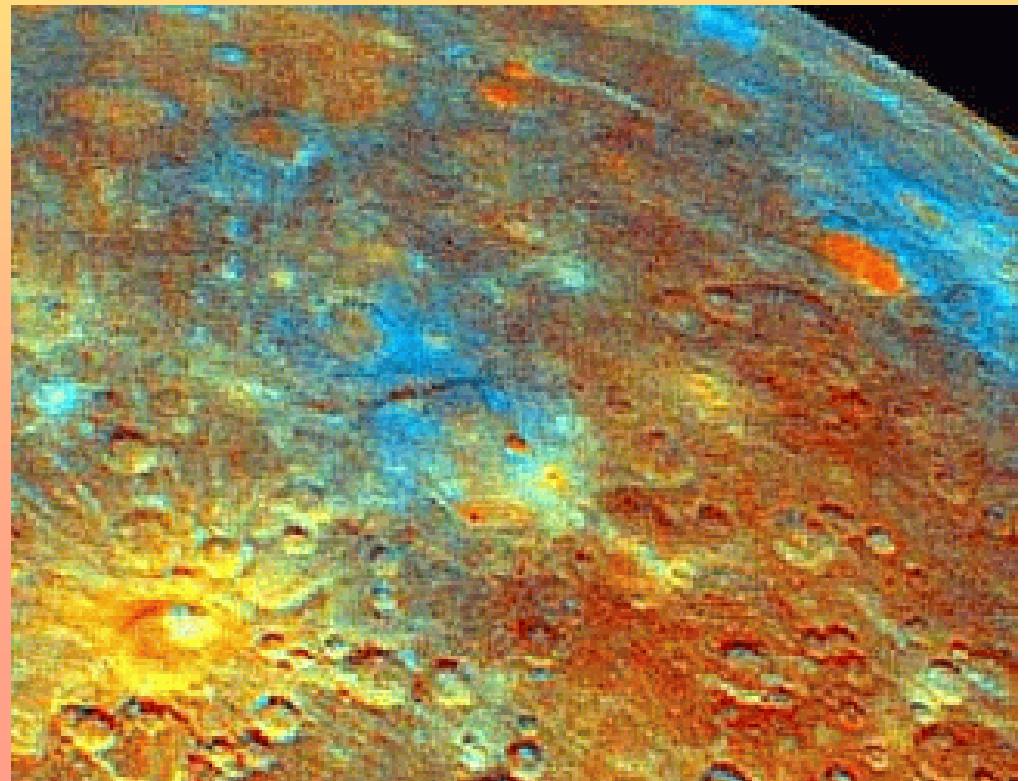


# Recent New Color Processing of Mariner 10's Images

- Although Mariner 10's vidicon system was primitive, enhanced colors (perhaps reflecting different mineralogy) may suggest that volcanism has occurred on Mercury.
- Do these colors provide an index that yields reliable mineralogical inferences?



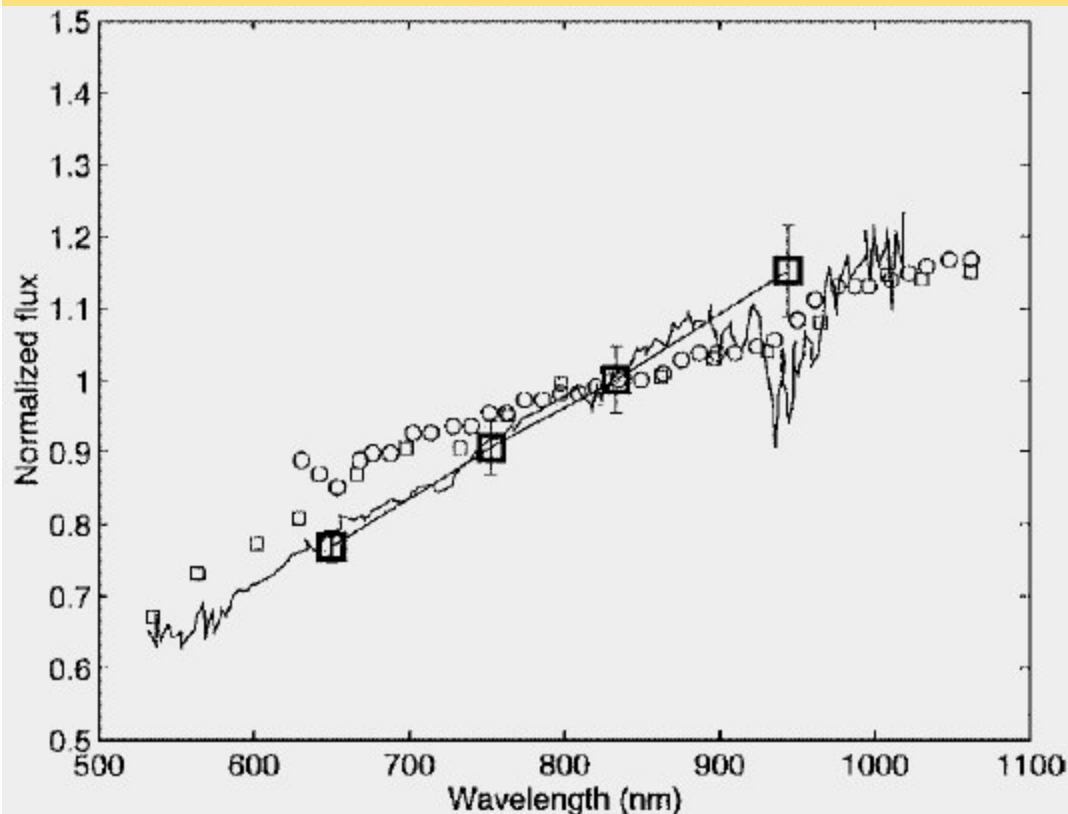
(Courtesy of Mark Robinson and Paul Lucey.)





# Is there or isn't there: ferrous iron? Or is Mercury's surface reduced?

- Putative 0.9 $\mu$ m feature appears absent
- Other modelling of color/albedo/near-to-mid-IR-spectra yield FeO + TiO<sub>2</sub> of 2 - 4% (e.g. Blewett *et al.*, 1997; Robinson & Taylor, 2001)



Warell (2002): SVST data  
(big boxes) compared with  
earlier spectra

Vilas (1985): all glass

ICARUS 64, 133-138 (1985)

## Mercury: Absence of Crystalline Fe<sup>2+</sup> in the Regolith

FAITH VILAS<sup>1,2</sup>

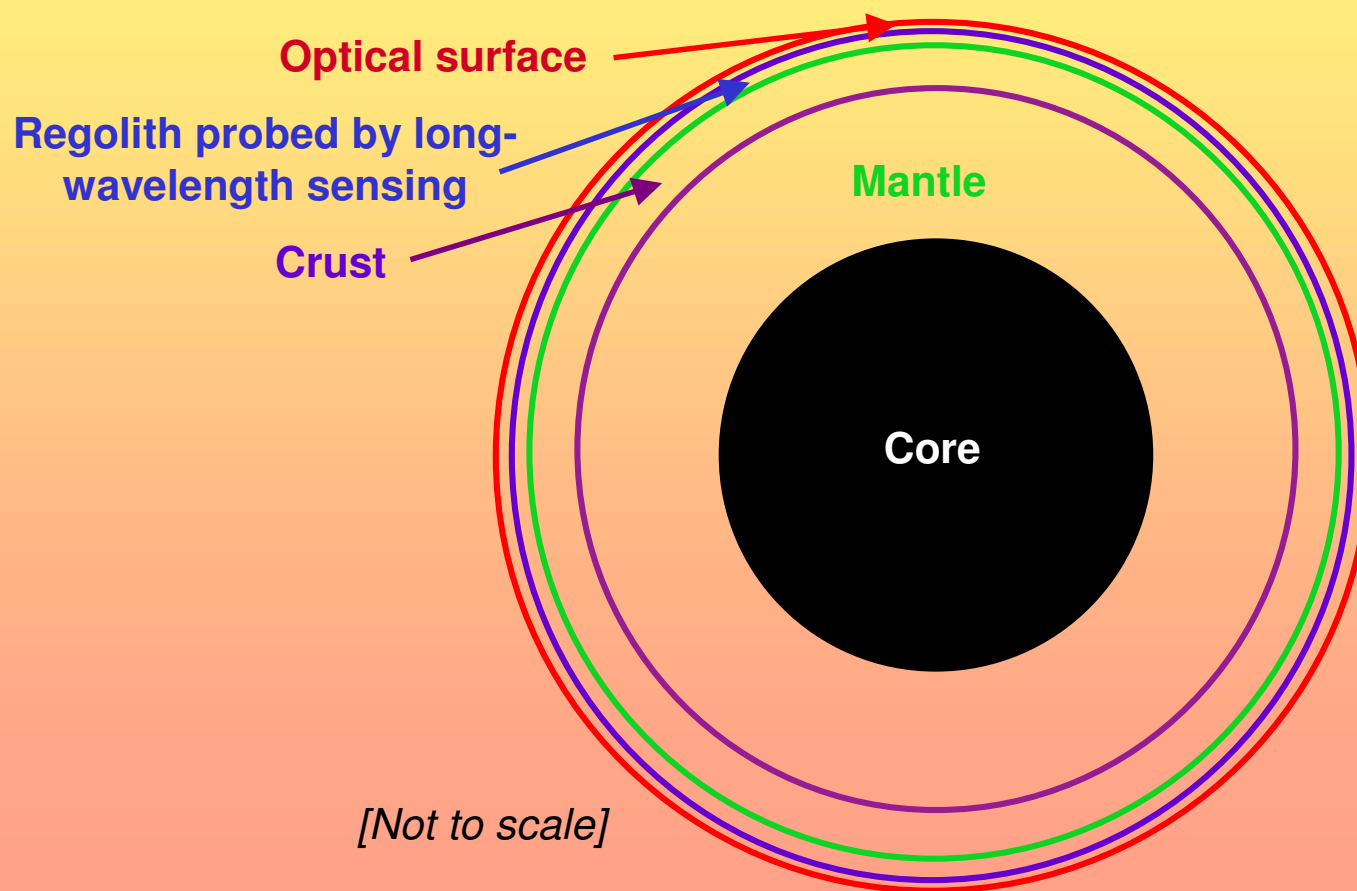
NASA Johnson Space Center/SN3, Houston, Texas 77058

Received April 29, 1985; revised June 3, 1985

Reflectance spectra of terrain on Mercury containing both smooth plains and intercrater plains were obtained using a charge-coupled device spectrograph on 24 November 1984. The composite spectrum covers the 0.53- to 1.02- $\mu$ m spectral range with a resolution of 17 Å. Absorption features due to telluric H<sub>2</sub>O absorption are clearly mapped around 0.73, 0.82, and 0.93  $\mu$ m. No evidence exists in the new spectrum for the proposed orthopyroxene absorption centered near 0.9  $\mu$ m seen in older spectra of this terrain. The surface material is probably highly reduced, with any iron present in metallic form. Based upon the new spectrum, a history of heavy micrometeoroid bombardment of the Mercurian surface is suggested, resulting in a surface regolith primarily comprised of agglutinates. © 1985 Academic Press, Inc.

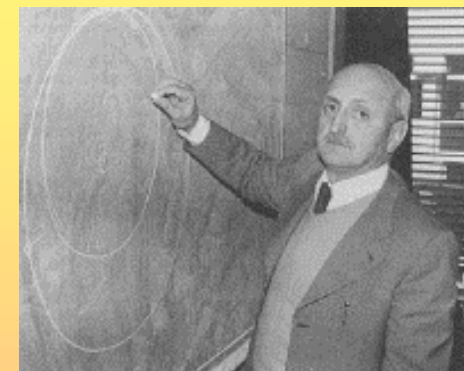
# Mercury's Surface, and Interior Layers

- What do we know of Mercury's bulk composition from observations of its surface?



## Transforming Mercury from an “Astronomical” to “Geological” Body

- As an astronomical target, small Mercury has been a challenge to characterize
- The only spacecraft mission to date (Mariner 10) was a very early, rather primitive spacecraft
  - limited spatial resolution (and no backside coverage)
  - virtually no spectral capabilities
  - vital “discoveries” (Na, K, polar ice deposits, unseen-side craters) have been made since, from Earth
- ***MESSENGER* and *Bepi Columbo* will transform Mercury into a planet with known composition, geology, and geophysics**

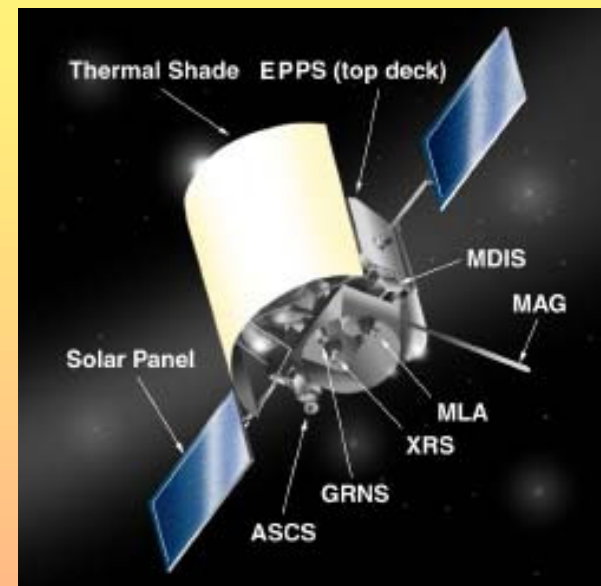




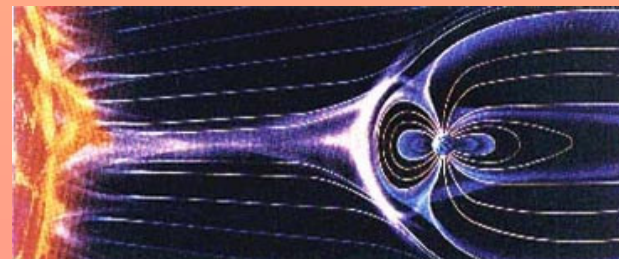
# MESSENGER: A *Discovery* Mission to Mercury

## Mercury Surface, Space Environment, Geochemistry and Ranging

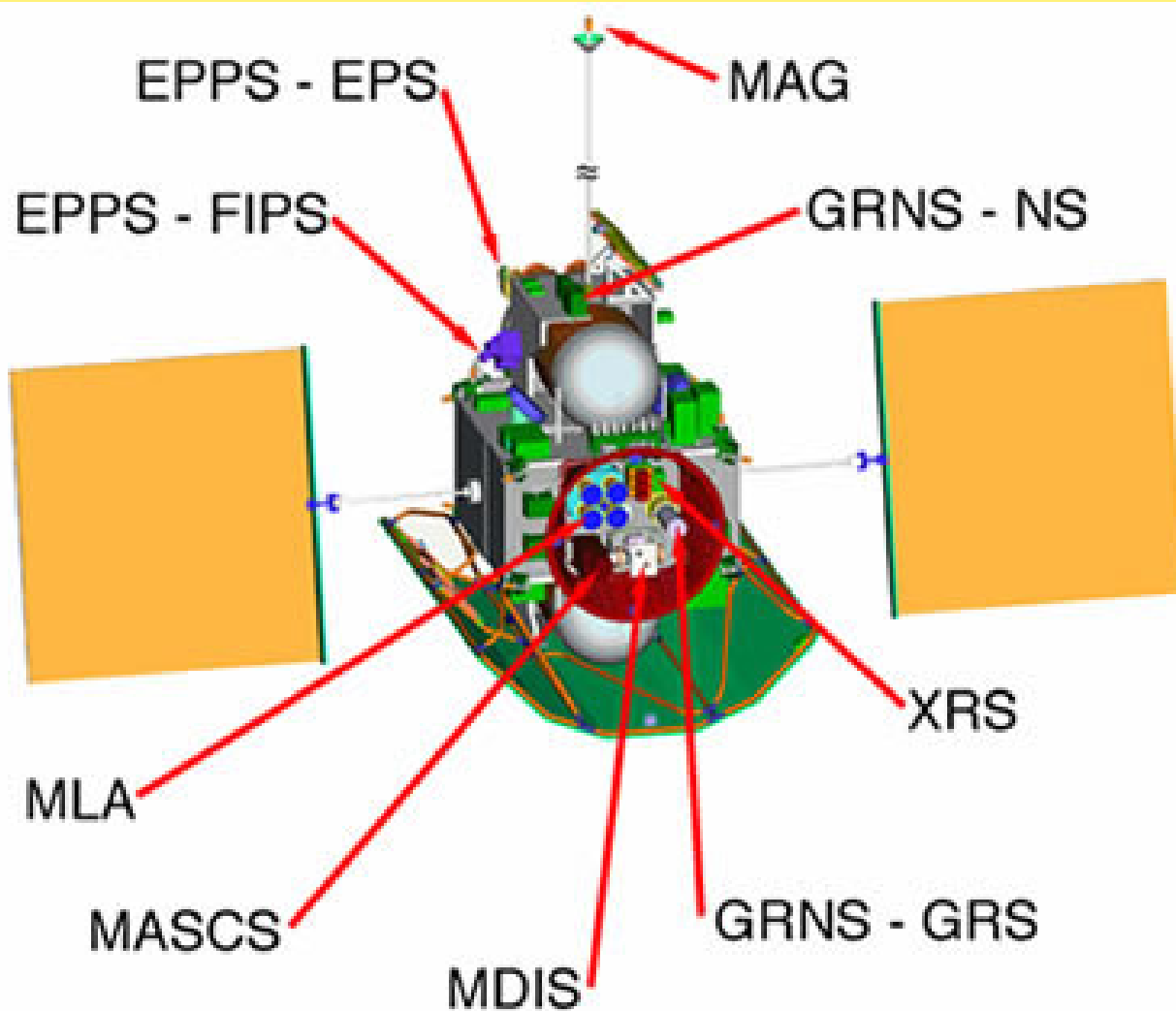
- MESSENGER is a low-cost, focused *Discovery* spacecraft, which has been built at Johns Hopkins Applied Physics Lab.
- It will be launched in May 2004
- It flies by Venus and Mercury
- Then it orbits Mercury for a full Earth-year, observing the planet with sophisticated instruments
- Designed for the harsh environs



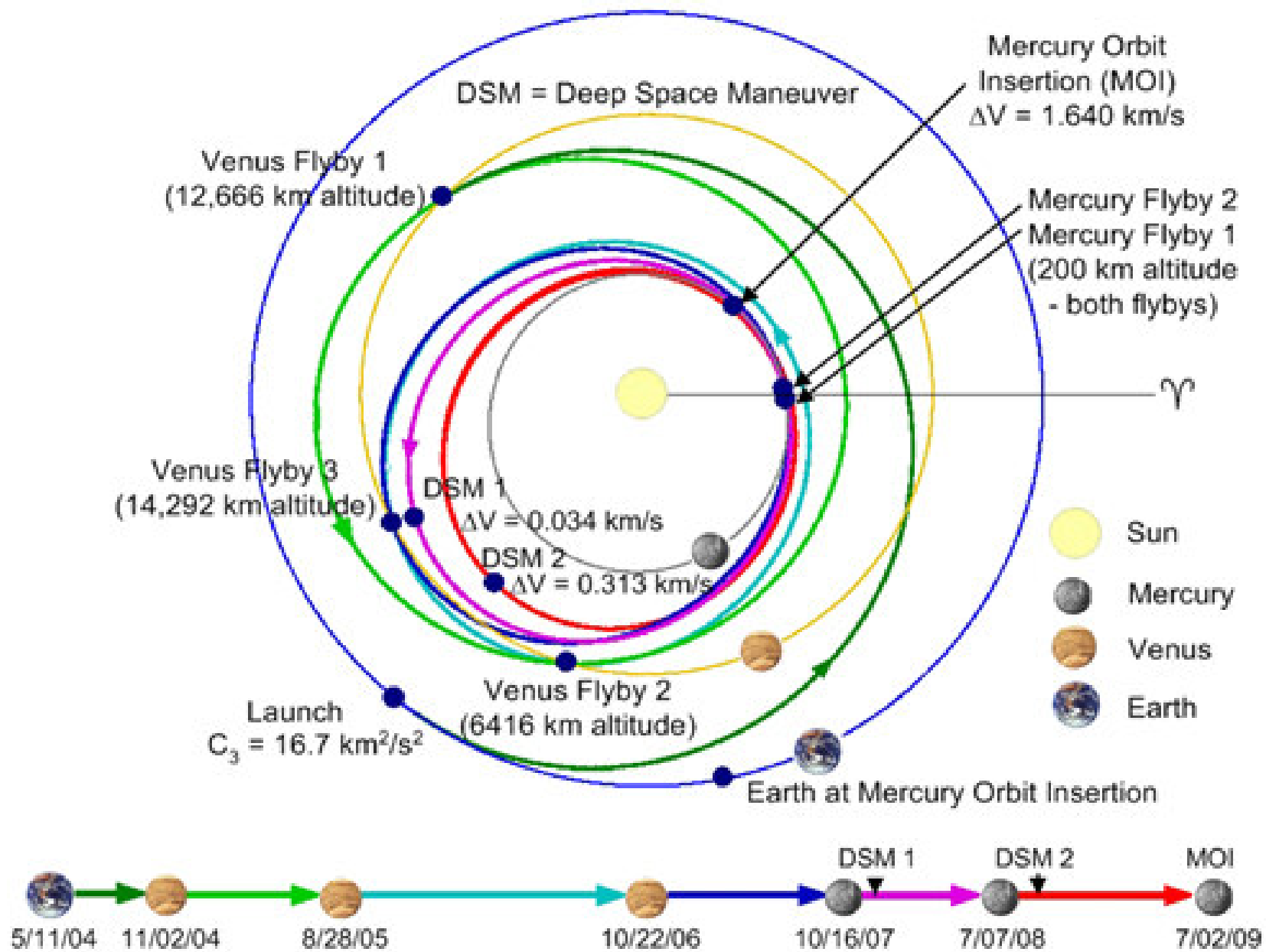
*Important science instruments  
and spacecraft components*



# MESSENGER Scientific Instrument Payload



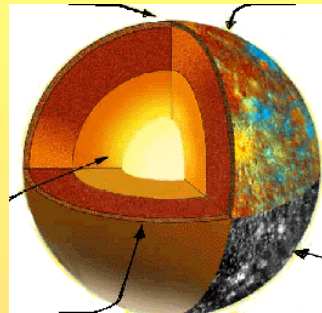
- MDIS = dual imaging system
- MASCS = infrared to UV spectrometer
- MAG = magnetometer
- MLA = laser altimeter
- GRNS = gamma-ray and neutron spectrometer
- EPPS = energetic particle & plasma spectrometer
- XRS = X-ray spectrometer



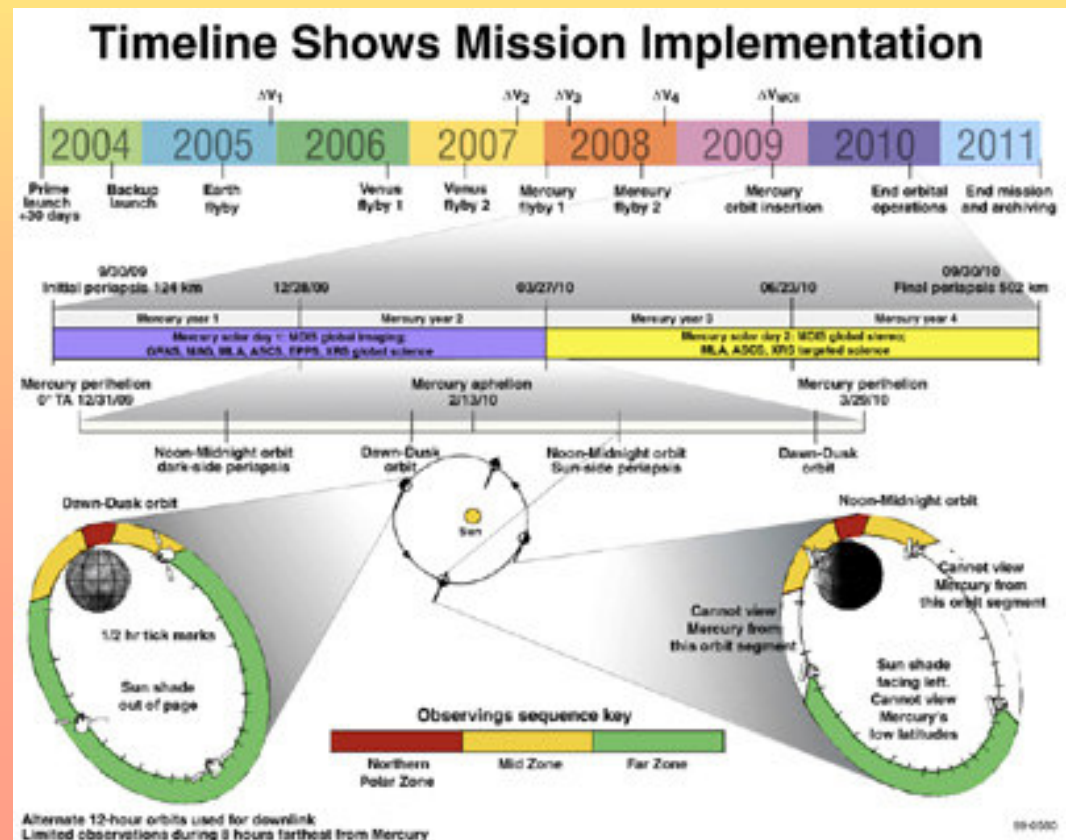


# MESSENGER's Timeline

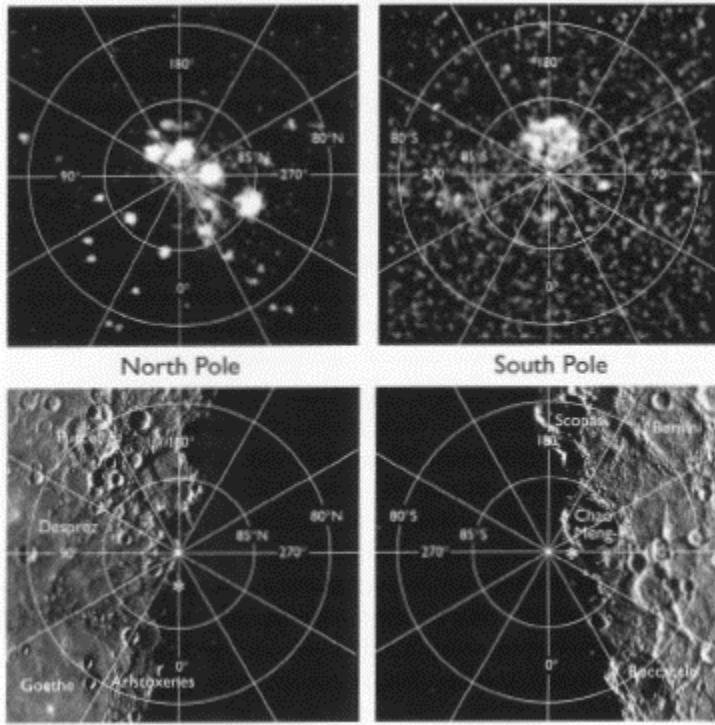
- Launch in 2004
- 3 Venus flybys (was 2)
- Two Mercury flybys (mapping unseen side and other science)
- One-year orbit, 2009 to 2010
  - Dawn-dusk orbit
  - Noon-midnight orbit
- Science analysis, 2011



(Timeline below is a bit obsolete, being based on a March 2004 launch. Now the launch will be in May 2004.)

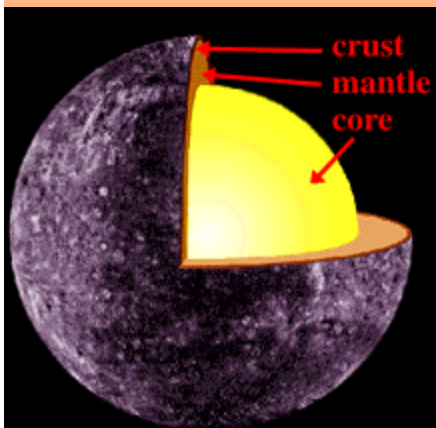
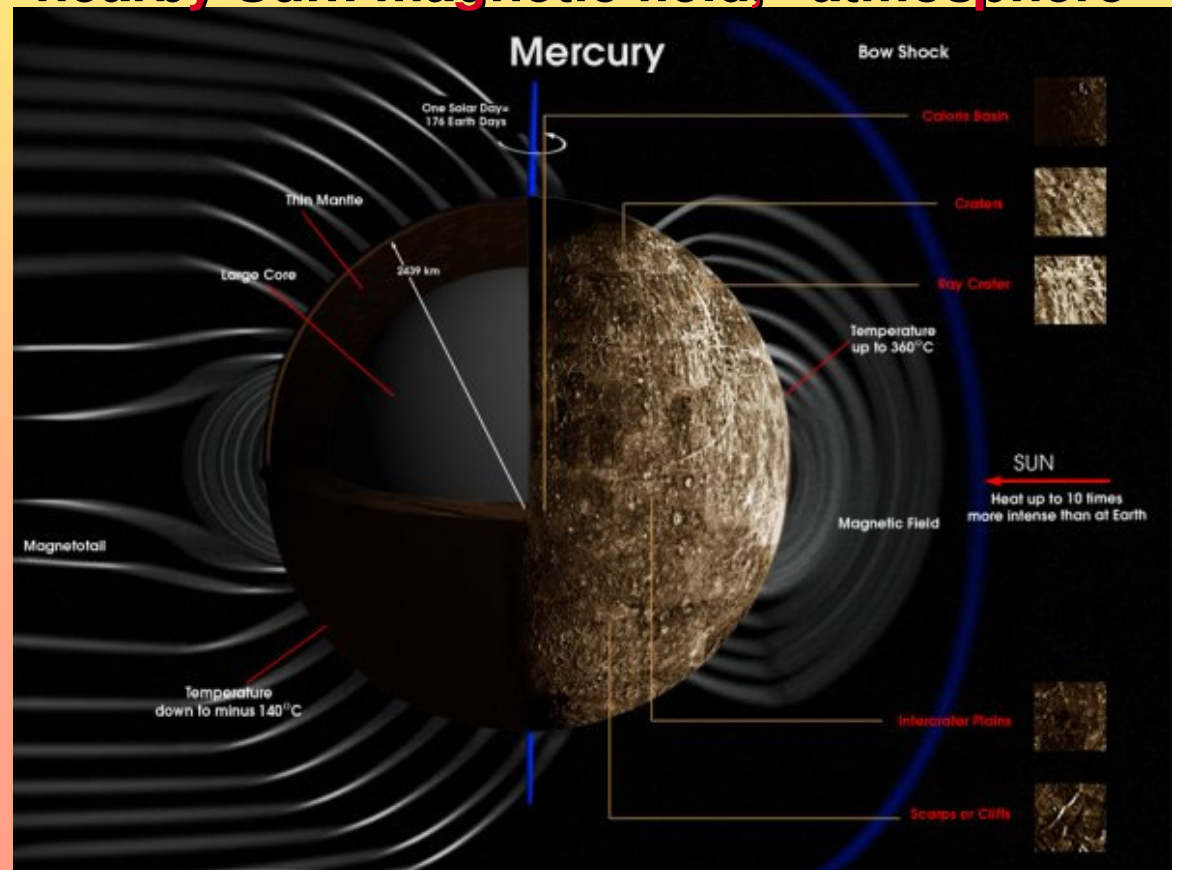


# Some MESSENGER Science Goals

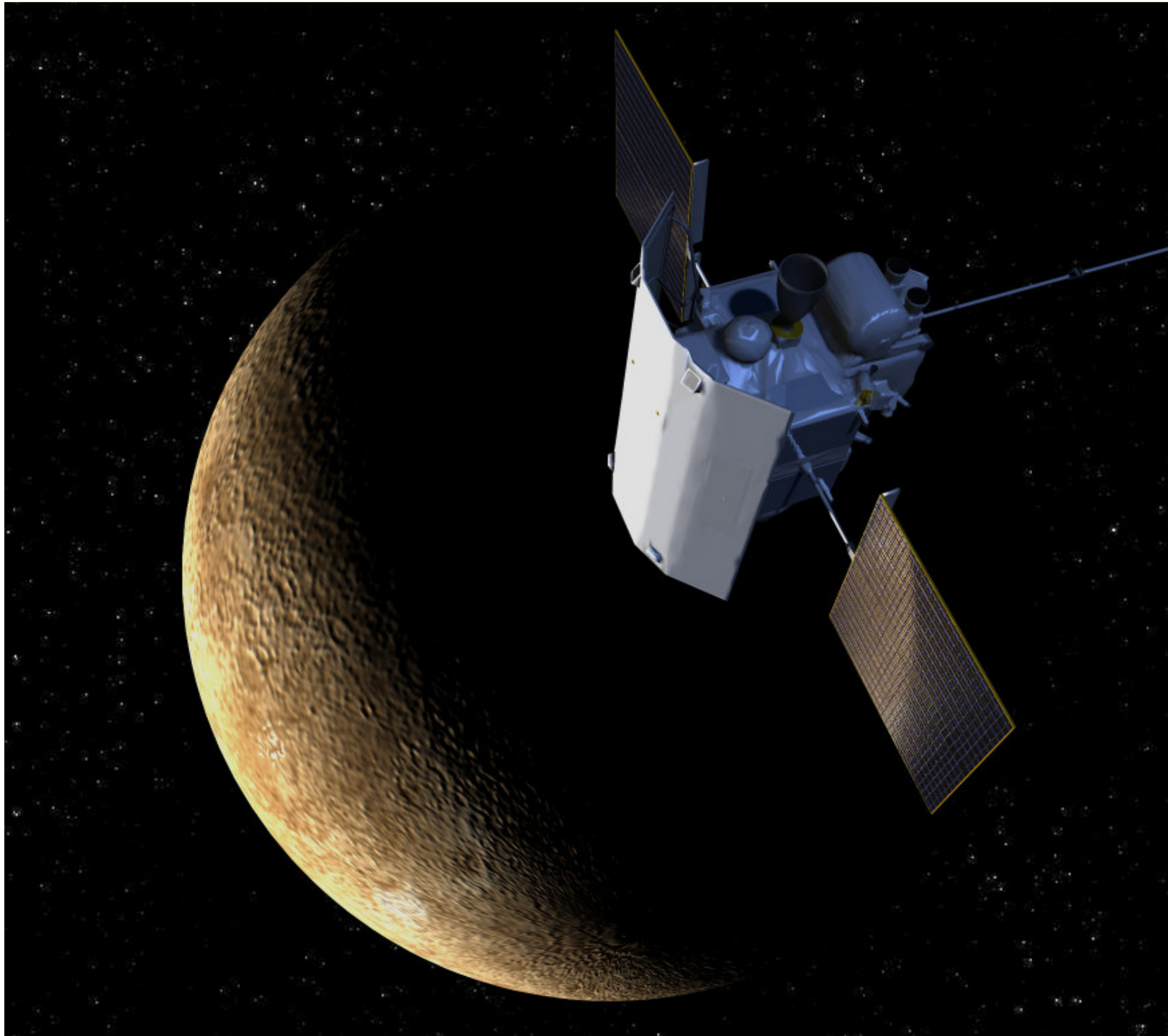


**Determine if Mercury's polar ice deposits are made of ice or sulphur**

**Study Mercury's interaction with the nearby Sun: magnetic field, "atmosphere"**



**Study structure of core**



*In orbit  
around  
Mercury  
(artist's  
view)*



## Mercury has *MUCH* to offer!

- Go out and look for Mercury when the sky is clear at the horizon...
- Follow the MESSENGER mission in the news, beginning with its spring 2004 launch
- Think about this small, hot world... under an enormous, scorching Sun (yet with ice at its poles!)
- Imagine the engineering genius that can send a spacecraft to work there for a year!



[\*http://messenger.jhuapl.edu\*](http://messenger.jhuapl.edu)